THE STATISTICAL EDUCATION OF TEACHERS (SET): AN AMERICAN STATISTICAL ASSOCIATION POLICY DOCUMENT

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The American Statistical Association (ASA) has as one of its strategic priorities K-12 teacher preparation in Statistics. The release and widespread adoption of the Common Core State Standards for Mathematics (CCSSM) in the United States have dramatically increased the expectations for teaching statistics especially in grades 6 through 12. Other countries are also including more Statistics at the K-12 level. The Conference Board of the Mathematical Sciences (CBMS) identified the statistical preparation of teachers as an area of concern in their recent publication of the Mathematical Education of Teachers 2 (MET2) document. This paper will briefly outline the SET document, a companion to the MET2 document and ASA's response to expanding the MET2 recommendations for answering the question: what preparation and support do K-12 teachers need to successfully support students' learning of Statistics?

INTRODUCTION

The opportunity of "statistical literacy" for all is upon us! Several countries internationally are including more Statistics in curriculums at the K-12 level. The release in 2012 and widespread adoption in 45 states (plus the District of Columbia) of the Common Core State Standards for Mathematics (CCSSM) have dramatically increased the amount of statistical content and expectations for teaching statistics in grades 6 through 12 in the United States of America. (CCSS, 2010) As one views the standards for Statistics, you may say, "This sounds similar to the course content in a high school Advanced Placement Statistics course or a college introductory statistics course". The statistics standards at K-12 are intended to introduce basis statistics topics at an intuitive and conceptual level utilizing case studies, technology, and simulation. In light of these increased expectations of delivering conceptually based statistical content at K-12, the Conference Board of the Mathematical Sciences (CBMS) identified the statistical preparation of teachers as an area of concern in the *Mathematics Education of Teachers 2* (MET2) document (CBMS, 2012). Despite the increased attention Statistics is receiving in national and state standards, research suggests that teachers are not likely to be adequately prepared to teach statistics (Batanero, et.al, 2011) at the level suggested in the American Statistics Association *Pre-K-12 Guidelines for Assessment and Instruction in Statistics Education* (GAISE) framework (Franklin, et.al, 2007).

RATIONALE AND WRITING TEAM

The Conference Board of Mathematical Sciences MET1 and MET2 documents emphasize the need for teacher preparation in statistics; however, the documents' primary focus is the mathematical education of teachers. (CBMS, 2001 and CBMS, 2012) The Joint American Statistical Association-National Council of Teachers of Mathematics (ASA-NCTM) Committee felt there was a critical need for a companion document entitled the Statistical Education of Teachers (SET). Although the MET2 document includes recommendations for the statistical training of K-12 teachers, ASA felt more detail was needed on the statistical content and pedagogy and a more cohesive understanding of the evolution of statistical topics and concepts from K-12. The ASA has the statistical preparation of K-12 teachers as one of its strategic priorities**.** Just as ASA took the lead with the Pre-K-12 GAISE Framework document in 2003, (Franklin and Garfield, 2006) the ASA executive board enthusiastically approved supporting a strategic initiative for the development and writing of the SET document.

A team of committed and dedicated writers is currently writing the document: Christine Franklin and Tim Jacobbe (co-chairs), Anna Bargagliotti, Gary Kader, Richard Scheaffer, and Denise Splanger. These writers are highly respected in the mathematics and statistics education communities for their professional efforts promoting statistics in writing national standards and resources for K-12, teacher preparation, and developing appropriate assessment for K-12 statistics. The work of the writing team will build on:

- Existing K-12 statistics standards and guidelines (Pre-K-12 GAISE Framework, NCTM Principal and Standards for School Mathematics, and the United States Common Core State Standards in Mathematics)
- Relevant research results from the studies of teaching and learning statistics
- Data on assessment items used in large scale and high stakes tests and the work of the NSF funded Levels of Conceptual Understanding in Statistics (LOCUS) project - the assessment piece of the Pre-K-12 GAISE Framework
- Experiences of teacher preparation institutions that are recognized leaders in the statistical preparation of K-12 teachers

In February 2013, a Joint Position Statement of the American Statistical Association and the National Council of Teachers of Mathematics on "Preparing K-12 Teachers of Statistics" was released (http://www.amstat.org/policy/pdfs/JointASA_NCTM_Statement.pdf). The position statement is as follows:

> Students, teachers, administrators, employers, and others increasingly recognize statistics as an important scientific field of study. Mathematics content standards emphasize that the development of statistical thinking begins in the early grades and extends into and beyond high school. To successfully develop students' statistical thinking, teachers must have deep knowledge and understanding of statistics and the way that students learn statistics. Consequently, the need is critical for high-quality preservice and in-service preparation and professional development that supports pre-K–12 teachers of mathematics, new and experienced, in developing their own statistical proficiency as well as their students' understanding of and skill in working with statistics.

The SET project is one of many ways ASA is showing its commitment to supporting the recommendations of this position statement.

GOALS OF SET
There are three main goals of SET: (1) To reach the appropriate audience for teacher preparation in Statistics, (2) To make recommendations and provide details for the statistical content and pedagogy needed by K-12 teachers to teach the national Statistics standards and (3) To make recommendations for how the statistical training of teachers can be incorporated into the overall curriculum of a student's teacher education curriculum.
We see the *audience* as three groups:

- *Mathematicians and Statisticians.* The primary audience is two- and four-college and university mathematics and statistics departments, and the individual mathematics and statistics faculty members within them who are responsible for educating mathematics teachers.
- *Mathematics educators.* Mathematics education faculty, including mathematics education researchers, teacher educators, and professional developers, form another important audience for this report.
- *Policy-makers.* Educational administrators and policy-makers at the local, state, and national levels as they work to provide young people with a strong mathematical and statistical preparation for the increasingly quantitative workplace. Teachers' knowledge of mathematics and statistics is central to this effort.

The *recommendations* for content and pedagogy will be literature based and based upon existing documents (i.e., *Pre-K-12 GAISE Framework and the CBMS MET2*). The field of Statistics like mathematics is an intellectually demanding field and especially with our K-12 teachers, the perception among teachers is they don't know the content, therefore they can't teach the statistics content. Our goal is to change that perception.
As a beginning foundation, the SET writing team has taken the six major recommendations of the MET2 document, stated in terms of mathematics, as our recommendations for statistics

where we include statistics alongside mathematics (see inserted parentheses) to maintain the spirit of the recommendations. From MET2, these recommendations are (CBMS, 2012, p.17-21):

1. Prospective teachers need mathematics (statistics) courses that develop a solid understanding of the mathematics (statistics) they will teach.
2. Coursework that allows time to engage in reasoning, explaining, and making sense of the mathematics (statistics) that prospective teachers will teach is needed to produce well started beginning teachers.
3. Throughout their careers, teachers need opportunities for continued professional growth in their mathematical (statistical) knowledge.
4. All courses and professional development experiences for mathematics teachers should develop the habits of mind of a mathematical (statistical) thinker, such as reasoning and explaining, modeling, seeing structure, and generalizing. Courses should also use the flexible, interactive styles of teaching that will enable teachers to develop these habits of mind in their students.
5. At institutions that educate teachers, teacher education must be recognized as an important part of a mathematics (statistics) department's mission and should be undertaken in collaboration with mathematics (statistics) education faculty. More mathematics (statistics) faculty need to become deeply involved in PreK–12 mathematics (and statistical) education by participating in preparation and professional development for teachers and becoming involved with local schools or districts.
6. Mathematicians (statisticians) should recognize the need for improving mathematics (statistics) teaching at all levels. Mathematics (statistics) education, including the mathematical (statistical) education of teachers, can be greatly strengthened by the growth of a mathematics (statistics) education community that includes mathematicians (statisticians) as one of many constituencies committed to working together to improve mathematics (statistics) instruction at all levels and to raise professional standards in teaching.

The writing team feels strongly that teachers should have a statistical content understanding that extends to the next school level. That is, elementary teachers should have a content understanding that covers middle school statistical content, middle school teachers have a content understanding that covers high school content, and high school teachers have a content understanding that covers the college introductory statistics course. The SET document will clearly outline the topics and concepts needed for teachers at each of these levels as well as detailed illustrative examples.

How best to incorporate the statistics content and pedagogy into a student's already demanding teacher education curriculum? The SET team will expand upon the recommendations made by MET2. We will strongly advocate for at least one course in Statistics that integrates both the content and pedagogy needed to teach Statistics at a particular school level.

CONCLUSION

The writing team has as its goal for the completion of the document as fall 2014 with the ASA board considering the document for approval before the end of December 2014. As drafts of the document are written, an advisory group of respected statistics and mathematics educators is reviewing the document.

Once approved by ASA, these guidelines will be posted on the ASA Website (www.amstat.org) and will be submitted to professional organizations such as NCTM, Mathematical Association of American (MAA), CBMS as well as to funding agencies such as National Science Foundation. The Joint ASA-NCTM committee will also sponsor printed versions of the SET report. We also desire for this document to be shared internationally as other countries work to improve their teacher preparation in Statistics at K-12.

ASA is again demonstrating its vision by supporting this necessary document for the national United States K-12 education community and to be shared with the international K-12 education community. Just as with the vision shown by supporting the Pre-K-12 GAISE Framework, a document that was available for the Common Core writers, we believe the SET

document is critical for teacher preparation institutions and various U.S. state departments of education in meeting the new and sudden challenges of infusing more statistics content and pedagogy into the training of pre-service and in-service teachers. The Pre-K-12 GAISE Framework has become influential internationally. We envision the same for the SET document – a special addition to ASA's support of the international year of statistics.

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